Research Article

Knowledge Status among Mothers Regarding Childhood Immunization and Causes of its Failure

Komal Bhatti[1,*], Asma Noreen[2], Mehrozia Nuzhat[3], Nadeem Noor[3], Mehtab Hussain[4], Jalal Uddin Akbar[1]

[1]*Department of Pediatrics, Baqai Medical Hospital, Karachi, Pakistan.*
[2]*Department of Pediatrics, Jinnah Medical & Dental Hospital, Karachi, Pakistan.*
[3]*Department of Pediatrics, Jinnah Medical College/ Sohail Trust Hospital, Karachi, Pakistan.*
[4]*Department of Pediatrics, Liaquat National Hospital and Medical College, Karachi, Pakistan.*

Abstract: Background: Mothers are a fundamental component of child health care services; therefore, their level of awareness and involvement is critical for the successful implementation of immunization programs.

Objective: To assess the knowledge status among mothers regarding childhood immunization and causes of its failure.

Materials and Methods: This cross-sectional study was done at the Department of Pediatric Medicine, Baqai Medical Hospital, Karachi, Pakistan during a period of 1st July 2025 to 31st December 2025, after the approval of Institutional Ethical and Review committee (Ref: BMU-IREB/15-2025/035/(FRREC-FM/05-2025/14, dated: June 04, 2025). A total of 147 mothers of children aged birth to 5 years were analyzed after consecutive sampling technique. Demographical information along with immunization status were documented. Maternal knowledge was evaluated adopting a 20-item self-designed questionnaire (Cronbach's α=0.82). Mothers who scored 12 or above (≥60% of total score) were classified as having adequate knowledge, while those who received a score <12 would be categorized as having inadequate knowledge. Data were analyzed using SPSS version 26.0, applying Chi-square and Fisher's exact tests with $p<0.05$ considered significant.

Result: In a total of 147 mothers, the mean age was 28.7±5.4 years. The mean of children was 4.2±0.6 years. Immunization status was found to be complete, partial and unimmunized in 108 (73.5%), 20 (13.6%) and 19 (12.9%) respectively. The mean maternal knowledge score was 12.6±2.4, with 83 (56.5%) having adequate knowledge. Significant association was found between knowledge and maternal education ($p<0.001$), residence ($p<0.001$), birth order ($p<0.001$), child's gender ($p=0.003$) and immunization status ($p<0.001$). Common causes of immunization failure included postponement 31 (48.4%) and fear of side effects 14 (21.9%).

Conclusion: Maternal knowledge shows important role in child immunization practices. The association of knowledge with maternal education, residence, and immunization status emphasizes the multifaceted nature of vaccine uptake.

Keywords: Knowledge, Immunization, Mothers, Failures, Barriers.

INTRODUCTION

Immunization has been identified as one of the most effective and evidence-based interventions for the prevention of diseases [1, 2]. Immunization has been critical in the eradication, elimination or control of various vaccine-preventable diseases (VPDs) [3, 4]. Despite the success recorded, various challenges have been identified including the lack of accessibility, long distances to health centers, misconceptions and lack of awareness about the importance of immunization [5].

The involvement of parents in the immunization program has been identified to be critical for the success of immunization especially the communication level between parents and healthcare providers which acts as a strong determinant for the success of immunization [6]. Lack of knowledge about the immunization program, including the immunization schedules and side effects, often results in the failure to complete the immunization program or delays in the administration of immunizations [7]. Knowledge about the immunization program, especially the time for immunization during the first 24 hours following birth, and the understanding that fever following immunization is part of the immunologic response, plays a critical role in the success of the immunization

* Address correspondence to this author at the Department of Pediatrics, Baqai Medical Hospital, Karachi, Pakistan.
Email: drkomalbhatti149@gmail.com

program.1 Knowledgeable and positive attitudes among mothers often result in adherence to the immunization program, immunization campaigns, and improved child health status [8].

Mothers are a fundamental component of child health care services; therefore, their level of awareness and involvement is critical for the successful implementation of immunization programs. Various research studies have shown that factors such as the age of mothers, education level, occupation, and family structure are positively correlated with knowledge and attitude score results [9, 10]. Institutions and digital media have also been recognized as important sources of information for mothers' awareness. Socioeconomic factors such as low socioeconomic status and lack of education are also thought to be related to low immunization rates. It seems important to evaluate the knowledge and attitudes of mothers regarding childhood immunization programs in a given region or country. The present study aims to assess the knowledge of mothers regarding childhood immunization and causes of its failure.

MATERIALS AND METHODS

This cross-sectional study was conducted at the Department of Pediatric Medicine at Baqai Medical Hospital, Karachi, Pakistan during 1st July 2025 to 31st December 2025 after the approval of Institutional Ethical and Review committee (Ref: BMU-IREB/15-2025/035/(FRREC-FM/05-2025/14, dated: June 04, 2025). The sample size was determined using WHO software for sample size calculation, considering a prevalence of adequate knowledge among mothers at 57.97%, with a margin of error of 8% and a 95% confidence level, resulting in a total of 147 participants [11]. A non-probability consecutive sampling technique was employed. Inclusion criteria were mothers who visited the outpatient department (OPD) with their children aged between birth and five years for routine checkups or immunization. Children without immunization cards were excluded. A written informed consent was obtained from all participating mothers before enrollment.

Data collection was conducted through face-to-face interviews, with responses recorded on a structured proforma by the principal investigator. Demographic and clinical variables were recorded. The immunized children were those who had taken all the vaccines according to their age group. Partial immunization was defined as a state where a child had initiated their vaccination schedule but had not yet completed all of the recommended doses for their specific age group. Non-immunized children were those who had never taken any recommended vaccine dose for their age group. Knowledge of the mother regarding immunization was measured using a 20-question questionnaire, which was prepared after a thorough review of the relevant literature and immunization recommendations by the World Health Organization [12]. The knowledge of the mother was validated by assessing it using a single-choice questionnaire that measured the knowledge of the mother regarding immunization and the benefits of immunization. Content validity of the questionnaire was done by asking a panel of three pediatricians and two public health specialists to review the questionnaire and assess whether it was sufficient to measure the knowledge of the mother regarding immunization. Minor linguistic changes were incorporated according to their feedback, focusing on improving interpretability, especially for mothers with low literacy skills. The pilot study was carried out on a group of 15 mothers not included in the main study to assess its reliability and feasibility, and the findings confirmed its internal consistency with a Cronbach's alpha value of 0.82, indicating good reliability. Each correct response was allocated a score of 1, whereas incorrect or unanswered questions were allocated a score of 0, making a total possible score of 0-20. Mothers who scored 12 or above (≥60% of total score) were classified as having adequate knowledge, while those who received a score <12 would be categorized as having inadequate knowledge. The cut off was determined using an absolute value based on a set pre-defined percentage of acceptable performance as is typical in cross-sectional evaluation studies of knowledge. Reasons for failure of immunization were identified and grouped into categories: unaware of need for follow-up doses (the child was given an initial dose, but no further doses were given because the mother was not aware of the need for further doses), vaccinator absent/vaccine unavailability (the vaccines were not given because of lack of vaccines or vaccinators), too busy (the mothers were too busy because of work, thus preventing timely vaccination, even if aware of its importance), fear of side reactions (the mothers deliberately did not vaccinate their children because of their concerns about side effects), and postponement (the mothers, even if aware of its importance, delayed vaccination because of personal reasons).

STATISTICAL ANALYSIS

Data analysis was performed using IBM-SPSS Statistics

version 26.0. Categorical variables including gender, marital status, maternal education, residence, birth order, number of children, immunization status, knowledge status, and reasons for failure were shown as frequency and percentages. Continuous variables such as maternal age and number of children were summarized as mean ± standard deviation, and in cases of non-normal distribution, median and interquartile range were reported. The normality of quantitative variables was assessed via the Shapiro-Wilk test. Association between categorical variables was analyzed using the binary logistic regression. Variables with $p<0.05$ in univariate analysis were entered were run in multivariable regression model with a significance threshold of $p<0.05$.

RESULT

In a total of 147 mothers, the mean age was 28.7±5.4 years, while the mean age of their children was 4.2±0.6 years. Of the 147 children, 64 (43.5%) were male and 83 (56.5%) were female. Regarding maternal education, 75 (51.0%) mothers had no formal education, 39 (26.5%) had completed primary education, 26 (17.7%) had attained secondary education, and 7 (4.8%) had completed intermediate-level education. In terms of residence, 87 (59.2%) mothers were from rural areas and 60 (40.8%) resided in urban areas. With respect to birth order, 65 (44.2%) children were first-born, 15 (10.2%) were second-born, 38 (25.9%) were third-born, and 29 (19.7%) were fourth-born. Regarding immunization status, 108 (73.5%) children were completely immunized according to the national immunization schedule, 20 (13.6%) were partially immunized, and 19 (12.9%) had not received any vaccines (Table **1**).

Table 1. Characteristics of Study Participants (n=147).

Characteristics		N (%)
Child's Gender	Male	64(43.5)
	Female	83(56.5)
Mother's Education	No Formal Education	75 (51)
	Primary	39 (26.5)
	Secondary	26 (17.7)
	Intermediate	7 (4.8)
Residence	Urban	60 (40.8)
	Rural	87 (59.2)
Birth Order	1st	65 (44.2)
	2nd	15 (10.2)
	3rd	38 (25.9)
	4th	29 (19.7)
Child Immunization Status	Complete	108 (73.5)
	Partial	20 (13.6)
	Not Done	19 (12.9)

The overall mean knowledge score of mothers regarding childhood immunization was 12.6±2.4. Based on the predefined scoring criteria, 83 (56.5%) mothers demonstrated adequate knowledge, whereas 64 (43.5%) exhibited inadequate knowledge. When responses to individual knowledge items were analyzed (Table **2**), 128 (87.1%) mothers acknowledged that vaccination prevents disease, and 76 (51.7%) believed that vaccination is applicable to all ages. A total of 83 (56.5%) recognized that there are different types of vaccines, and 89 (60.5%) were aware that vaccination may be contraindicated in certain health conditions. Seventy-eight (53.1%) agreed that vaccination could be associated with adverse reactions, and 93 (63.3%) correctly identified the routes of vaccine administration. Only 44 (29.9%) mothers knew that frozen vaccines should not be used, while 66 (44.9%) were aware that the vial seal should be broken at the time of use. Knowledge about the importance of following immunization guidelines was reported by 121 (82.3%) mothers. Thirty-seven (25.2%) mothers perceived vaccination as harmful, whereas 134 (91.2%) expressed overall favorability toward vaccination and 122 (83.0%) stated they would recommend it to others. Ninety-six (65.3%) knew that vaccination should be initiated within the first week of life, and 127 (86.4%) reported being informed about vaccination. Exposure to vaccine-related media was reported in 62 (42.2%) mothers, and 54 (36.7%) had watched related television programs. However, 123 (83.7%) indicated exposure to televised vaccination campaigns, and 122 (83.0%) had vaccinated all their children. Fifty-six (38.1%) had administered vaccines beyond the national immunization schedule, and 134 (91.2%) had encouraged others to vaccinate their children.

Among 39 mothers with partial or incomplete immunization, 31 (79.4%) reported postponement of vaccination as the main reason for delay, 14 (35.8%) expressed fear of vaccine-related side effects, 12 (30.7%) cited the absence of a vaccinator or unavailability of vaccines, and 7 (17.9%) attributed to time constraints or being preoccupied with other responsibilities.

Adequate knowledge was significantly higher among mothers of male children ($p=0.003$). A statistically significant association was observed between maternal education and knowledge about immunization ($p<0.001$). Residence was significantly associated with knowl-

edge (p<0.001), as 67 (77.0%) mothers from rural areas demonstrated adequate knowledge compared with 16 (26.7%) from urban areas. Birth order showed a strong association (p<0.001) with knowledge about childhood immunization. Immunization status was significantly associated with maternal knowledge (p<0.001). The univariate association between knowledge levels and sociodemographic characteristics is presented in Table **3**. In multivariable regression analysis, association of knowledge status and immunization was also found as presented in Table **4**.

Table 2. Responses Regarding Immunization Knowledge of Mothers (n=147).

	Question	Yes	No
1	Vaccination prevents disease?	128 (87.1%)	19 (12.9%)
2	Vaccination is for all ages?	76 (51.7%)	71 (48.3%)
3	There are different types of vaccination?	83 (56.5%)	64 (43.5%)
4	In some health situations, vaccines should not be given?	89 (60.5%)	58 (39.5%)
5	Vaccination is associated with adverse reactions?	78 (53.1%)	69 (46.9%)
6	Do you know routes of vaccination?	93 (63.3%)	54 (36.7%)
7	Vaccines should not be used if freeze?	44 (29.9%)	103 (70.1%)
8	The seal must be broken at the time of its use?	66 (44.9%)	81 (55.1%)
9	The immunization guideline must be followed?	121 (82.3%)	26 (17.7%)
10	Vaccination is harmful?	37 (25.2%)	110 (74.8%)
11	Are you in favor of vaccination?	134 (91.2%)	13 (8.8%)
12	Will recommend vaccination to others?	122 (83.0%)	25 (17.0%)
13	Vaccination should be initiated in the first week of age?	96 (65.3%)	51 (34.7%)
14	Were you informed about vaccination?	127 (86.4%)	20 (13.6%)
15	Did you read about vaccination in the media?	62 (42.2%)	85 (57.8%)
16	Did you see a television program about vaccination?	54 (36.7%)	93 (63.3%)
17	Did you see vaccine awareness program videos on social media?	123 (83.7%)	24 (16.3%)
18	Have you vaccinated all of your children?	122 (83.0%)	25 (17.0%)
19	Apart from NIS, have you given other vaccines to your children?	56 (38.1%)	91 (61.9%)
20	Have you motivated others for vaccinating their children?	134(91.2%)	13 (8.8%)

Table 3. Univariate Association of Knowledge about Childhood Immunization with Characteristics of Study Participants (N=147).

Characteristics		Knowledge about Childhood Immunization		Crude OR with 95% CI	P-value
		Adequate (%)	Inadequate (%)		
Child's Gender	Male	45(70.3)	19(29.7)	Ref.	
	Female	38(45.8)	45(54.2)	0.4 (0.2-0.7)	*0.003
Child's Age	≤12 months	76(56.7)	58(43.3)	Ref.	
	>12 months	7(53.8)	6(46.2)	0.9 (0.3-2.8)	0.842
Mother's Age	≤30 years	64(58.7)	45(41.3)	Ref.	
	>30 years	19(50)	19(50)	0.7 (0.3-1.5)	0.351
Number of Children	≤2 children	39(54.2)	33(45.8)	Ref.	
	>2 children	44(58.7)	31(41.3)	1.2 (0.6-2.3)	0.582
Mother's Education	No Formal Education	50(66.7)	25(33.3)	Ref.	
	Primary	19(48.7)	20(51.3)	0.5 (0.2-1.1)	-
	Secondary	7(26.9)	19(73.1)	0.2 (0.1-0.5)	-
	Intermediate	7(100)	0(0)	-	-

Continue

Continue

Residence	Urban	16(26.7)	44(73.3)	Ref.	
	Rural	67(77)	20(23)	9.2 (4.3-19.7)	*<0.001
Birth Order	1st	39(60)	26(40)	Ref.	
	2nd	15(100)	-	-	-
	3rd	25(65.8)	13(34.2)	1.3 (0.6-3.0)	-
	4th	4(13.8)	25(86.2)	0.1 (0.1-0.3)	-
Immunization Status	Complete	69(63.9)	39(36.1)	Ref.	
	Partial	1(5.0)	19(95)	0.2 (0.1-0.4)	*0.001
	Not Done	13(68.4)	6(31.6)	1.2 (1.1-3.5)	*<0.001

CI: Confidence interval, Ref: Reference category, *Significant at p<0.05.

Table 4. Multivariable Association of Knowledge about Childhood Immunization with Characteristics of Study Participants (N=147).

Characteristics		Adjusted Odds Ratio	95% CI	p-value
Child's Gender	Male	Ref.		
	Female	0.6	0.4-0.8	*0.016
Residence	Urban	Ref.		
	Rural	7.2	3.2-16.4	*0.001
Immunization Status	Complete	Ref.		
	Partial	0.2	0.1-0.5	*<0.001
	Not Done	1.3	1.1-3.1	*<0.001

CI: Confidence interval, Ref: Reference category, *Significant at p<0.05.

DISCUSSION

The present study identified that 56.5% of mothers had adequate knowledge regarding childhood immunization, with a mean knowledge score of 12.6±2.4. Dildar *et al.* [13], showed that 65.6% of the mothers had sufficient knowledge of immunization but 34.4% had no awareness of vaccination schedules and their side effects. This study found that 87.1% mothers had awareness of the importance of vaccination against diseases. Yasir *et al.* [14], which showed that 88% of the mothers had awareness of the importance of vaccination for their children. This study also revealed that nearly all the mothers (99.2%) had awareness of the importance of vaccines against diseases. This result is similar to that of Naeem *et al.* [1], where nearly all the mothers had awareness of the importance of vaccines against diseases but incomplete vaccination was still present among the children. This indicates that awareness of the importance of vaccination alone may not ensure compliance. A large number of the mothers in the present study (53.1%) had awareness of the adverse effects of vaccines. This result was similar to that of Nassar *et al.* [15], which showed that 57.5% of the parents had limited knowledge of the possible adverse effects and contraindications of vaccines. Ateeq and colleagues [16] noted only 19.8% of the parents had knowledge of the appropriate age of vaccine administration.

In the current study, 65.3% of mothers knew that vaccination should be initiated within the first week of life. This observation resonates with Yasir *et al.* [14], who reported that 90% of mothers were aware that immunization begins at birth, while Dildar *et al.* [13], noted that 38% lacked knowledge of the correct timing for the first dose. The association between maternal education and knowledge status in this study was statistically significant (p<0.001), with higher education linked to better knowledge levels. These findings are consistent with Iltaf *et al.* [17], who reported a strong relationship between education and maternal knowledge (p<0.001), and Nassar *et al.* [15], who demonstrated that parental education and income were key determinants of vaccination knowledge and practices. Khan *et al.* [18], also observed that parents with education less than secondary level were more likely to have incompletely immunized children. These findings collectively affirm that educational attainment remains a powerful determinant of immunization awareness, likely because educated mothers are better equipped to comprehend healthcare messages and navigate the healthcare system. A significant relationship was also observed between maternal residence and knowledge level, with rural mothers showing higher adequate knowledge (77.0%) than urban mothers (26.7%) (p<0.001). This finding contrasts Lebanese region where urban mothers

had higher knowledge and practice scores, while rural regions such as Beqaa exhibited lower knowledge and poor vaccination practices [19]. The difference may reflect the relative effectiveness of Pakistan's community-based outreach programs, such as the Lady Health Worker initiative, which often targets rural communities more intensively than urban populations.

The current study mothers of first and second-born children showing higher adequate knowledge (60.0% and 100.0% respectively) compared to those with fourth-born children (13.8%). Verulava *et al.* [20], reported similar findings, where incomplete vaccination was frequently associated with limited maternal knowledge about follow-up doses and a lack of attention to subsequent children in larger families. Repeated exposure to immunization programs does not necessarily improve knowledge retention, indicating that motivation and counseling should be sustained across successive births.

The study demonstrated a statistically significant association between knowledge and immunization status ($p<0.001$), where 63.9% of mothers of fully immunized children had adequate knowledge, while only 5.0% of mothers of partially immunized children demonstrated similar knowledge. Rayee *et al.* [21], reported that mothers of fully immunized children had more favorable knowledge, attitudes, and practices compared with those of partially or non-immunized children. The linkage between maternal knowledge and vaccination completion has also been documented by Elbert *et al.* [22], who found that low knowledge and negative attitude were strong predictors of incomplete vaccination, with odds ratios of 2.65 and 5.33 respectively.

Among mothers with partial or non-immunizing status, the leading reason for vaccination failure in this study was postponement of vaccination, reported by most of the participants (79.4%), followed by fear of side reactions (35.8%), vaccinator absence or vaccine unavailability (30.7%), and maternal time constraints (17.9%). Khan *et al.* [18], reported that lack of information (13.0%) and lack of motivation (7.1%) were primary contributors to incomplete vaccination, whereas Bofarraj identified child illness, nonavailability of vaccine, and social reasons as major determinants of incomplete immunization [23]. Ullah *et al.* [24], further highlighted vaccinator attitudes, misconceptions, and overcrowded centers as reasons for defaulting. The similarity in barriers across studies reflects that both system-level and caregiver-level factors coexist, affecting vaccine compliance [25, 26].

LIMITATIONS

Several limitations must be acknowledged. The study was conducted at a single tertiary-care hospital using a non-probability sampling method, which may limit the generalizability of findings to the broader population. Mothers visiting a hospital setting may have greater exposure to healthcare information compared to those in remote communities. The use of self-reported data could have introduced recall bias, particularly regarding reasons for missed vaccinations.

CONCLUSION

Maternal knowledge shows important role in child immunization practices. The association of knowledge with maternal education, residence, and immunization status emphasizes the multifaceted nature of vaccine uptake.

AUTHORS' CONTRIBUTION

Komal Bhatti: Conceptualization, Study Design, Methodology, Data analysis and interpretation, Writing Draft and Final approval, final proof to be published.

Asma Noreen: Study Design, Critical review and revision the manuscript, and Final approval, final proof to be published.

Mehrozia Nuzhat, Nadeem Noor, Mehtab Hussain and **Jalal Uddin Akbar**: Methodology, Data analysis and interpretation, Writing Draft and Final approval, final proof to be published.

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Declared none.

ETHICAL DECLARATIONS

Data Availability Statement

Data will be available from the corresponding author upon a reasonable request.

Ethical Approval

This cross-sectional study was conducted at the Department of Pediatric Medicine at Baqai Medical Hospital, Karachi, Pakistan during 1st July 2025 to 31st December 2025 after the approval of Institutional Ethical and Review committee (Ref: BMU-IREB/15-2025/035/(FRREC-FM/05-2025/14, dated: June 04, 2025).

Consent to Participate

Written consent was sought from parents prior to study commencement.

Consent for Publication

All authors provide consent to publish the work.

Conflict of Interest

Declared None.

Competing Interest/Funding

Declared none.

Use of AI-Assisted Technologies

The authors declare to avail AI-assisted services via Grok for grammar and language editing purpose.

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